

In this Issue

Feeling emotional: the amygdala links emotional perception and experience

The term ‘emotion’ most commonly denotes a specific phenomenal state, such as the solemn weightiness associated with sadness or the lightness of being associated with joy. Human affective neuroscience has begun to pin down the elusive neuroanatomy of these most experientially prominent of mental experiences. One of the brain structures consistently associated with emotional functioning is the amygdaloid complex (Phan *et al.*, 2002). Numerous neuroimaging studies have shown the amygdala varies with emotional experience in both healthy and mood disordered populations, pointing to its central role in emotional phenomenology. One difficulty with this apparent association is that emotion like cognition is not a single entity but is a multi-component process. Emotions reflect a constellation of diverse but correlated central neurocognitive and peripheral physiologic events. For example, witnessing a gruesome automobile accident is highly negatively valent, may involve specific appraisals related to fear or sadness, results in central and peripheral autonomic arousal, is attention grabbing thereby demanding to be the central focus of awareness, and in the following months and years may be associated with vivid reminiscences. In the safer confines of the lab or the bore of an MRI scanner, the amygdala has been associated to some extent with all of these putative functions. As such, amygdala activity may represent the generation of emotional experience itself, and/or it may reflect sundry aspects of emotional information processing correlated with emotional experience. In this issue, Feldman Barrett *et al.* demonstrate amygdala responses represent a critical nexus between the propensity for emotional experience and emotional interactions with perceptual encoding. The amygdala’s role in feeling emotions may be tied to enhanced sensitivity toward emotional perception.

Feldman Barrett *et al.* examined amygdala activation and its relation to emotional experience through the use of experience sampling. For 1 month three times daily, participants were probed via handheld PDA to indicate their present emotional state. One year following, participants were presented with backwardly masked fearful facial expressions during fMRI to index sensitivity of perceptual encoding of emotional events. Individual differences in propensity for negative affect, as indexed by experience sampling, were correlated with magnitude of amygdala

response to presented fear faces. Moreover, in participants reporting increased anxiety during scanning, amygdala responses were associated with enhanced perceptual encoding of faces as indicated by increased fusiform activity. These results suggest that the amygdala may contribute to emotional experience by setting the appropriate preconditions for its expression: enhancing attention and associated perceptual encoding of emotional events, and thereby increasing their subjective salience.

Considering the mounting neuroimaging evidence consistent with an important role of the amygdala in generating affective experience there is surprisingly little direct evidence of disordered emotional experience following amygdala damage (Anderson and Phelps 2000; Anderson and Phelps 2002; Tranel *et al.*, 2006), compared with evidence of the amygdala’s central role in the emotional enhancement of mnemonic (Cahill *et al.*, 1995) and perceptual processes (Anderson and Phelps 2001; Vuilleumier *et al.*, 2004; Adolphs *et al.*, 2005). For instance, patients with amygdala lesions provide retrospective reports of affective states (daily reflections) and traits (yearly reflections) of similar magnitude, frequency and underlying covariance structure to healthy controls (Anderson and Phelps, 2002). When asked to relive emotions, examinations of facial efference reveal that patients with bilateral amygdala damage display remarkably intact emotional expressions, including fear, despite pronounced impairments in the perception of these same signals (Anderson and Phelps, 2000). The results of such lesion studies, however, regard introspective emotional experiences that are associated with complex abstract factors and not directly tied to momentary environmental events. Many emotional experiences involve ruminations upon the past or future, thereby involving representations of threats and rewards in the absence of in the moment environmental stimulation. Such forms of emotional replay and forecasting may depend upon evolutionary more recent prefrontal neocortical representations rather than the amygdala alone. By contrast, the results of Feldman-Barrett *et al.* suggest that the amygdala’s role is more related to momentary experiential states and enhanced attention and sensitivity toward encoding events surrounding these states.

The amygdala is neuroanatomically positioned to make a rapid and coarse appraisal of the state of the world, and via

robust feedback projections, alter the perceptual process by enhancing the encoding of events of potential self importance. Neuroimaging studies have shown that emotionally arousing scenes vigorously engage early primary and secondary visual cortex (Bradley *et al.*, 2003). Emotions thus bias attention to focus on events associated with subjective and physiologic arousal, shaping the ultimate contents of awareness (Anderson, 2005). Such arousal based modulatory effects depend on the integrity of the amygdala, with amygdala lesions eliminating the subjective biasing of perception toward the significant relative to the mundane, rendering the attentional landscape flat (Anderson and Phelps, 2001). Directly corroborating the results of Feldman-Barrett, enhanced extrastriate cortical responses to facial expressions of fear are correlated with magnitude of amygdala response (Morris *et al.*, 1998), and these enhanced extrastriate responses are abolished following amygdala damage (Vuilleumier *et al.*, 2004). The amygdala's role in evaluating the emotional value of fearful faces similarly depends on the ability to correctly attend to and encode their important features (Adolphs *et al.*, 2005). If all the world's a stage, then the amygdala may be the emotional spotlight, shedding light on the most dramatic players of our life story.

The amygdala may thus represent embodied attention—the crucial link between central (mental) and peripheral (bodily) resources. Attention and awareness should be coupled with information of sufficient importance to result in autonomic activation and associated mobilization of peripheral metabolic resources, such as through altered respiration and heart rate. This redirecting of bodily physiologic resources may serve as the common primitive foundations of both attention and emotional experience. This common origin supports why emotional states are strongly correlated with how we think about and perceive the environment (Barrett and Niedenthal, 2004; Anderson, 2005; Rowe *et al.*, 2007). More than a simple correlation, Feldman-Barrett *et al.*'s results suggest that emotional experience and individual differences therein may critically depend upon how we attend to the world (Barrett and Niedenthal, 2004; Anderson, 2005). Rather than being an ancillary consequence of, altered attention to emotional events may be part and parcel of emotional experience itself.

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